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OF THE

TORREY BOTANICAL CLUB

VOL. 36

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Errata

Page 3, line 11, *for* VIRGINICA *read* VIRGINIANA.
Page 41, last line, *for* Brainard *read* Brainerd.
Page 70, line 15 from bottom, *for* qiu *read* qui.
Page 111, line 21, for *P. parviflorus* read *S. parviflorus.*
Page 209, line 3, for Greenii read Greenei.
Page 502, lines 15 and 30, *for* Mocino *read* Mociño.
Page 513, last line, and page 514, lines 1 and 2, *for* **Mocino** *read* **Mociño.**
Page 637, line 9 from bottom, *for* VACCININIUM *read* VACCINIUM.

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BULLETIN

OF THE

TORREY BOTANICAL CLUB

JANUARY, 1909

The ferns and flowering plants of Nantucket. — IV

EUGENE P. BICKNELL

ARACEAE

ARISAEMA PUSILLUM (Peck) Nash.

Locally rather common in low or wet shaded thickets, mainly in the northeast quarter: Quaise; Polpis; Pocomo; Squam. In fresh flower June 7, some fruit turning red Aug. 13, 1906; mature fruit Sept. 17, 1907.

The Nantucket plant is more especially the state or form known as *A. Stewardsonii* Britton. This, in its representative development, shows a considerable divergence from typical *A. pusillum* but, in localities on Long Island where it grows in abundance, the evidence appears unmistakable that the two plants are extreme variations of a single species. The corrugated spathe, although a noteworthy character, is an unstable one and may or may not be shown by plants growing together in the same colony. I have not, however, seen it as strongly emphasized in plants from anywhere on the coastal plain as in the type specimens from the mountain region of east Pennsylvania.

On Long Island, *A. pusillum* is essentially a plant of the coastal plain, where it replaces *A. triphyllum* of the hilly country. The two species are not at all constantly different in size, and *A. pusillum* when stoutly grown fully gains the proportions of good-sized examples of *A. triphyllum*. Nor is the color of the spathe always distinctive, that of *A. pusillum*, normally of an uninterrupted black-purple, being sometimes greenish and purple-striped or, exception-

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ally, as destitute of any purplish tinge as the palest-flowered examples of *A. triphyllum*. The essential points of distinction in *A. pusillum*, in addition to such variable differences as smaller size and more slender habit, narrower leaf-segments, deeper-colored and more narrowly lanceolate spathe, which is less decurved forward and with relatively narrower and longer tubular portion, is the slender, non-clavate spadix and brighter green color of the leaves which are more shining on the lower surface and never become distinctly pale or glaucous-whitened beneath as in *A. triphyllum*.

The largest example of *A. pusillum* found on Nantucket had the stem 1.5 cm. thick at the base and measured 32 inches to the tip of the longest leaf.

Arisaema triphyllum does not appear to occur on the island.

ACORUS CALAMUS L.

Wet meadows, pools, and overflowed muddy places, common. Spadices nearly full size June 7.

LEMNACEAE

LEMNA MINOR L.

Common in Long and Miacomet ponds; ditches west of the town; Millbrook Swamp.

LEMNA TRISULCA L.

Common with the preceding in Long Pond and with it also in ditches west of the town.

XYRIDACEAE

XYRIS FLEXUOSA Muhl.

Rather common in sandy bogs and along pond shores; Maxcy's Pond; Shawkemo; Polpis; Watt's Run; Tom Never's Pond. Flowering through August and September, sometimes when less than 5 cm. high.

This small state of the plant was doubtless the basis of the record in Mrs. Owen's catalogue of *Xyris flexuosa* var. *pusilla* A. Gray (*X. montana* H. Ries). This species would scarcely be expected on Nantucket and careful search seems to show that it does not occur there.

XYRIS CAROLINIANA Walt.

Local, but common about some of the bogs in Polpis; Almanac Pond; bog west of Sankaty.

ERIOCAULACEAE

ERIOCAULON SEPTANGULARE With.

In shallow water or wet sand about the borders of a number of ponds, especially Tom Never's, Gibbs' and Maxcy's ponds, and smaller ponds in Polpis. Leaves beginning to show June 8; some fresh heads after the middle of September.

COMMELINACEAE

* TRADESCANTIA VIRGINICA L.

Sparingly established on roadside banks at several places near the town in dry sterile soil. First noticed Aug. 6, 1906 — leaves only; first flowers June 8, 1908.

PONTEDERIACEAE

PONTEDERIA CORDATA L.

Very common in ponds and pools. Leaves just appearing June 8; still some flowers late in September. In the autumn the leaves often become deep blackish-purple.

* PONTEDERIA CORDATA ANGUSTIFOLIA (Pursh) Torr.

The narrow-leaved pickerel weed may be merely a state or condition of the common species, but until this has been established by proof it seems proper to allow it separate recognition. On Nantucket it contrasts strikingly with typical *cordata* and seems to maintain its leaf characters under diverse conditions. The leaves, although often very narrowly triangular-lanceolate, may be equally broad with those of *cordata*, but they are more tapering and are truncate to openly cordate at the base instead of deeply sagittate-cordate as are the ovate to ovate-oblong leaves of the typical plant.

It is common in several of the Polpis ponds and I did not find it anywhere mixing with the cordate-leaved species.

HETERANTHERA DUBIA (Jacq.) MacM.

Reported by Mrs. Owen from Long and Miacomet ponds on the authority of Mr. Morong; I did not meet with it.

JUNCACEAE

JUNCUS EFFUSUS L.

Common; in great luxuriance and of unusual size in Tom Never's Swamp. Inflorescence just appearing June 7; mostly dried in August.

The cyme of this rush, like that of a number of our species, varies from open and diffuse to compact (var. *compactus* Lej. & Cour.), but its form is too unstable to be made the basis of any true distinction. Better characters for the subdivision of this species are to be found in the size and form of the perianth-parts and capsule. On Nantucket very typical examples of the close-flowered state are frequent, the inflorescence sometimes forming a dense glomerule not over 1 cm. in diameter; but the two states of the plant pass readily into each other and the close, subglobose head of the one may be seen opening out into the loose cyme of the other even among the clustered stems of the same tuft.

* JUNCUS BALTICUS Willd.

Sandy levels in the marshes along the "Creeks"; sparingly below the "Cliff." Nearly in flower June 7; cyme mostly dried by August.

Note. — *Juncus filiformis* L. is given in Mrs. Owen's catalogue as common, but it seems evident that some other species was mistaken for it.

JUNCUS BUFONIUS L.

Common on sandy pond shores, low roadsides, and wet places generally. In flower from early June until the end of September or later.

JUNCUS GERARDI Lois.

Abundant, forming a large part of the vegetation of the level salt marshes. In full flower in June; inflorescence dried in August.

JUNCUS TENUIS Willd.

Common and variable, presenting a number of distinct-appearing forms ranging from low and densely tufted (6–12 cm. high) with congested cymes 5–10 mm. long, to tall and lax (3–5 dm. high) with elongated, branched inflorescence 6–13 cm. long. Inflorescence just appearing June 7.

A shade form occurring in dry thickets is characterized by extremely slender culms, growing singly or a few together, and a very sparse inflorescence of only 1–9 flowers, some of them borne on thread-form branches or pedicels sometimes 7 cm. long; the lanceolate-subulate perianth-parts are unusually thin and membranous and conspicuously white-margined.

A very slender and somewhat rigid form which grew in sandy soil near Sachacha Pond has elongated very narrow and involute leaves and bracts, the latter erect and becoming 15 cm. long, and congested cymes, the perianth-parts thickened and somewhat shining. The ligule is shorter, firmer, and less scarious than in typical *tenuis* and the character and aspect of the plant suggests some involvement with *Juncus dichotomus*, a small form of which was associated with it.

An equally aberrant form has been determined by Doctor Wiegand, who kindly examined all of my Nantucket material of this group, as

* JUNCUS TENUIS ANTHELATUS Wiegand.

This was collected near Millbrook Swamp, Aug. 19, 1906.

JUNCUS GREENEI Oakes & Tuckerm.

A characteristic rush of Nantucket, occurring everywhere on the dry moors and commons or sometimes in low sandy places growing with *Juncus dichotomus*.

A rather noteworthy modification of this plant occurs in partly shaded grassy places among the pines near Miacomet Pond. The culms, unlike those of the typical plant, which are erect and stiffly clustered, rise singly or a few together and are very slender and elongated, becoming 8 dm. long and finally declined or prostrate; the inflorescence is sparse and few-flowered and subtended by bracts sometimes 2 dm. long.

* JUNCUS DICHOTOMUS Ell.

Very common in all quarters in low sandy places. Inflorescence just appearing June 7.

Two forms of this rush are to be especially noted — one, which appears to be the typical plant, becomes 8 dm. tall and bears somewhat open cymes of strictly secund, sessile flowers; the other

form is lower and stiffer with more or less densely congested cymes mostly only 1–3 cm. high.

Another form, if it be not a distinct species, as I have long been inclined to regard it, is more slender than typical *J. dichotomus*, with fewer-flowered, less secund inflorescence, the flowers rather smaller, with shorter, less rigid perianth parts, 2.5–3.5 mm. long, and some of them distinctly pedicelled; the capsule is somewhat more ovoid and smaller, 2–3 mm. high, and commonly of a deeper reddish-brown color; the leaves are equally filiform-terete with those of the type but their auricles are usually less cartilaginous. This plant was found at several places and I have also collected it at Van Cortlandt Park, New York, and on Long Island.

JUNCUS MARGINATUS Rostk.

Infrequent but met with at several widely separated stations.

* JUNCUS ARISTULATUS Michx.

Further study of this rush on Nantucket (see Rhodora **6**: 174. 1904) shows that it occupies a general area extending nearly three miles in an east and west direction and about one and a half miles wide, lying east and north of the middle of the island. Within this section it was met with at a dozen or more localities, nowhere in abundance but often in a condition of exceptional vigor and fruitfulness. The largest examples were 1 m. tall with the larger leaves 7 mm. wide. It is to be found from Shimmo Creek to Pout Ponds, Wigwam Pond, several of the ponds in Polpis, and in Quaise. In September, 1907, two plants were observed at Maxcy's Pond within the western half of the island. In fresh flower Aug. 7, 1906.

JUNCUS PELOCARPUS E. Meyer.

Very common on sandy pond shores and in wet places.

JUNCUS MILITARIS Bigel.

Rather common, forming extensive growths in some of the ponds.

JUNCUS ARTICULATUS L.

Common in wet places and about the shores of ponds and pools.

Note. — *Juncus nodosus* L. is included in Mrs. Owen's catalogue on the authority of Professor Edward S. Burgess. In regard to this Professor Burgess writes me that he does not now recall having collected this plant on Nantucket and that there is quite possibly some mistake in the record.

JUNCUS CANADENSIS J. Gay.

Abundant in low grounds and widely variable, presenting very diverse-appearing forms.

Note. — *Juncus canadensis* var. *coarctatus* Engelm. [*J. brevicaudatus* (Engelm.) Fernald] is included in Mrs. Owen's list. The species may occur but, if so, should be attested as a Nantucket plant by a more specific record.

JUNCUS ACUMINATUS Michx.

Common on pond shores and in wet places generally. On Sept. 2, 1904, it was observed about ponds on the south shore, growing in wet sand and quite generally entering into a second flowering period, many fresh stems with unfolding inflorescence arising among the earlier stems on which the cymes had matured long before and become dried and brown.

JUNCOIDES CAMPESTRE (L.) Kuntze.

Common either in damp or in dry situations. In full flower June 7; by the middle of August it is scarcely to be found except for an occasional withered stem which may chance to persist.

In the recently published Gray's New Manual of Botany, it is pointed out that our plant is not the same as the European with which it has always been supposed to be conspecific, and it appears under the name *Luzula campestris* var. *multiflora* (Ehrh.) Čelak., also a European plant.

MELANTHACEAE

OAKESIA SESSILIFOLIA (L.) Wats.

In low thickets, apparently not common: Millbrook Swamp; Polpis thickets. No flowers remaining June 9.

LILIACEAE

HEMEROCALLIS FULVA L.

Occasional by fence-borders and roadsides and in old fields about and near the town. Large flower-buds June 20.

LILIUM PHILADELPHICUM L.

Somewhat locally common, mainly on the middle eastern side of the island, especially among the Shawkemo Hills; Saul's Hills; South Pasture; near Long Pond. In full flower during the first two weeks of August, 1906, indicating a much later flowering-period on Nantucket than on the mainland. The plants are mostly dwarf, often not over 12 cm. high, including the flower, which, even in such small plants, is of normal size and may be fully as long as the stem. Flowers often in pairs; in one instance, three together.

LILIUM SUPERBUM L.

Rather uncommon, in bogs and low grounds: Polpis; Pocomo; Squam; west of Sankaty; Trot's Swamp; never many plants together but some of large size. No flowers seen; green capsules observed from the middle of August to the middle of September.

ALETRIS FARINOSA L.

Locally common, especially in the southeast quarter and over the dry commons towards the south shore; also in Polpis and in Squam. Stems a few inches high by the middle of June; spikes of flowers dried by early August.

CONVALLARIACEAE

* ASPARAGUS OFFICINALIS L.

Frequent along field-borders and roadsides and in neglected places; apparently spreading and occasionally met with far from cultivated neighborhoods. In full flower June 7.

* VAGNERA RACEMOSA (L.) Morong.

Grows freely in a few thickets, as on Rattlesnake Bank, Shimmo Creek Bank, and in Polpis, and occurs very sparingly elsewhere, as in Tom Never's Swamp and in Squam. In full flower June 15; heavily fruited Aug. 7, 1906; fruit fully ripe Sept. 11, 1907.

VAGNERA STELLATA (L.) Morong.

Grows in close beds of considerable extent in openings among the pine scrub about the middle of the island; some dwarf plants on the commons towards Monomoy; Acquidness Point; cedar thicket on Coskaty. In flower June 7; fruit ripe Sept. 11, 1907.

UNIFOLIUM CANADENSE (Desf.) Greene.

Locally abundant in low thickets, especially about Tom Never's Swamp and in Polpis; Shawkemo; Rattlesnake Bank; Pocomo; Trot's Swamp; Long Pond. In flower June 7; fruit well developed June 15; some fruit remaining Sept. 15, 1907.

SALOMONIA BIFLORA (Walt.) Britton.

Scarce and local; Rattlesnake Bank; Polpis thickets. Some dried flowers remaining June 7; ripe fruit Sept. 11, 1907.

MEDEOLA VIRGINIANA L.

Infrequent; Rattlesnake Bank; low thickets in Shawkemo and Polpis. In flower June 7.

SMILACEAE

SMILAX HERBACEA L.

Shrubby banks and thickets, infrequent and met with only east and north of the middle of the island; sometimes growing with exceptional vigor. Shimmo Creek Bank; Rattlesnake Bank and thicket to the east; Squam, at Watt's Run and east along the Wauwinet road. Just in flower June 7; fruit ripe Sept. 17, 1907. On Rattlesnake Bank it had climbed to a height of 10–12 feet, producing peduncles 18 cm. long, borne down by the heavy umbels of as many as fifty-five berries, the larger umbels 7 cm. in diameter.

SMILAX ROTUNDIFOLIA L.

The fully typical plant is common in low thickets, becoming stout and high-climbing in favorable situations and sometimes forming an impenetrable thorny tangle. In flower and with young fruit June 9; no mature fruit seen.

SMILAX ROTUNDIFOLIA QUADRANGULARIS (Muhl.) Wood.

Common in dry places about the borders of thickets or among the low open growth covering sandy levels. Just in flower June 15.

In its extreme form this plant affords a pronounced contrast to typical *rotundifolia* and I would say of it that it remains to be determined whether it represents merely a state assumed by the species in dry and sandy soils or is a derivative now so inde-

pendently established as to merit the specific rank accorded it by Muhlenberg.

Its habit is often erect and little climbing and it seems never to acquire the height and strong development of typical *rotundifolia*. The stem is more or less quadrangular, often definitely so throughout, and becomes numerously short-, zigzag-branched above. The leaves are narrower than in *rotundifolia* and less cordate, if at all so; the stem-leaves rarely if ever cordate-orbicular and broader than long, but ovate or somewhat triangular-ovate; those of the branches very small and numerous and often ovate-lanceolate from a truncate base, or even with slightly concave sides above a somewhat dilated base, showing an approach to the fiddle-shaped leaves of *Smilax tamnoides*. The leaves are also of a somewhat different texture from those of *S. rotundifolia*, firmer and more membranous and more shining beneath, the three primary veins more prominent and more or less roughened with cartilaginous or spinulose processes which extend along the petioles and sometimes also around the entire margin of the leaf. The petioles are shorter than those of *S. rotundifolia*, while the peduncles are longer — longer than the petioles in the one case, shorter in the other. Not many specimens were found in flower, however, and an extended comparison of these characters is not here possible.

Note. — *Smilax tamnoides* L. was attributed to Nantucket in Mrs. Owen's catalogue on the authority of Mr. Dame, and the supposed occurrence of this species in New England has been based upon this record. Not meeting with the plant in my earlier explorations, I searched carefully for it on repeated occasions and finally became convinced that it had never occurred on Nantucket and that *Smilax quadrangularis* had been mistaken for it. This conclusion has been confirmed by Professor Fernald, who writes me on the subject as follows: "In the herbarium of the New England Botanical Club is a sheet of sterile branches of the Dame material which was listed by Mrs. Owen as *Smilax tamnoides*. There is a smaller twig in the Gray Herbarium. Both sheets show the plant to be *S. rotundifolia* var. *quadrangularis*. They have the quadrangular branches and the spinulose-margined teeth and I think there is no doubt that they are, as you supposed, the var. *quadrangularis*. Some of the leaves are fiddle-shaped and

this character doubtless misled Mr. Dame and Dr. Morong and others who started the records which have now been passed along."

SMILAX GLAUCA Walt.

Common, either in dry or in moist thickets, and more generally dispersed than *S. rotundifolia* or *S. quadrangularis*. Not found in flower or in fruit.

AMARYLLIDACEAE

HYPOXIS HIRSUTA (L.) Coville.

Apparently rare. Recorded by Mrs. Owen without mention of any locality. It was not observed by me until 1908, when it was found growing sparingly on dryish levels at the west side of Trot's Swamp, a small, slender form of the plant just in flower June 10.

IRIDACEAE

IRIS VERSICOLOR L.

Common in low meadows and in wet muddy places and about the borders of ponds and pools. In full flower June 7.

IRIS PRISMATICA L.

Common in low grounds, often in damp or even dry sandy soil. First flowers June 11.

* SISYRINCHIUM GRAMINOIDES Bicknell.

Frequent in damp grassy places or locally common, as in low grounds near "Ram Island," Pocomo; sparingly below the "Cliff," with *S. atlanticum*; near Shawaukemmo Spring; Polpis; towards Quidnet. In full flower June 7; belated flowers Aug. 10, 1906. Some specimens with unusually elongated peduncles up to 19.5 cm. long.

* SISYRINCHIUM ATLANTICUM Bicknell.

Common in low grounds in many parts of the island, by preference in damp sandy soil. In full flower June 7; mostly dried up and little noticeable by August. Near Trot's Swamp, with the flowers of adjoining plants, sky-blue or deep reddish-purple, in striking contrast.

SISYRINCHIUM ARENICOLA Bicknell.

One of the characteristic Nantucket plants, occurring in dry sandy places all over the island. In full flower June 7; belated flowers as late as Sept. 20, 1907.

ORCHIDACEAE

CYPRIPEDIUM ACAULE Ait.

Local, mostly within the southern half of the island from Hummock Pond to 'Sconset; pine grove east of Hummock Pond; east of Miacomet Pond; South Pasture; oak barrens in southeast quarter; borders of Tom Never's Swamp. Some fresh flowers in the shade of pines as late as June 17.

GYMNADENIOPSIS CLAVELLATA (Michx.) Rydb.

A close group of eleven well-fruited plants in open low ground near the head of Long Pond, Sept. 10, 1904; a scattered colony in wet sphagnum on the south side of Sachacha Pond, Sept. 19, 1907. Recorded from Long Pond by Mrs. Owen.

BLEPHARIGLOTTIS BLEPHARIGLOTTIS (Willd.) Rydb.

Common in sandy bogs: Tom Never's Swamp; 'Sconset; Polpis Bogs; Pout Ponds; Watt's Run. Some flowers left Aug. 16, 1906; a belated raceme of flowers Aug. 31, 1904; mature fruit Sept. 15, 1907. Mrs. Owen has recorded var. *holopetala* Gray from "Near edge of swamp opposite Bloomingdale."

BLEPHARIGLOTTIS CILIARIS (L.) Rydb.

Mrs. Owen has recorded a single plant found in 1872 between Siasconset and Polpis.

BLEPHARIGLOTTIS LACERA (Michx.) Rydb.

Frequent or rather common, occurring at widely separated points, but rarely more than a few plants in each locality. Some remaining flowers as late as the second week of August, 1906.

POGONIA OPHIOGLOSSOIDES (L.) Ker.

Abundant in open bogs. Small, precocious flowers in a drying bog June 11; generally coming into bloom June 18; some late flowers in the second week of August, 1906.

LIMODORUM TUBEROSUM L.

Common in bogs. Green flower buds June 18.

ARETHUSA BULBOSA L.

Frequent or rather common in low grounds, often about the borders of swamps. In full flower June 7.

IBIDIUM GRACILE (Bigel.) House.

Scattered plants are rather common in dry open places, sometimes growing in pure sand, occasionally with *I. Beckii*. First flowers Aug. 11, 1906, blooming through September. In August when *I. Beckii* is in full flower, this species, which has a rather later flowering-period, appears to be much the less common, or even rare, but in September when in full bloom, it seems to be equally common with *I. Beckii* or even somewhat more so.

IBIDIUM BECKII (Lindl.) House.

Common throughout in sandy open places, often in pure sand, usually single plants or a few together. In full flower early in August, continuing in bloom at least until after the middle of September.

IBIDIUM CERNUUM (L.) House.

Common in low grounds, coming into flower late in August.

ACHROANTHES UNIFOLIA (Michx.) Raf.

South Pasture, not far from the railroad at about the third mile — a scattered colony of perhaps a dozen plants, in full flower Aug. 6, 1906. Reported from hills west of Sachacha and west of Bloomingdale, 1886.

LEPTORCHIS LOESELII (L.) MacM.

Reported, like the preceding, on the authority of Mr. Dame, from wet bank on the shore of Sachacha, 1886. I met with it only at Watt's Run, where two plants were found growing in deep, wet sphagnum Sept. 17, 1907. One of these plants was of unusual size, bearing a closely fruited raceme of thirteen capsules; the plant was 26 cm. high, its larger leaf 24 cm. long, the larger capsules 1.5 cm. high.

SALICACEAE

POPULUS ALBA L.

Spontaneous and spreading in the neighborhood of the town and elsewhere; on the bluff at 'Sconset; many sprouts and groups of young trees about a long-abandoned farm in Polpis.

* POPULUS CANDICANS Ait.

Established and spreading here and there, especially about the sites of almost obliterated farms. On the border of Trot's Swamp is a scattered group of trees of various ages, the largest about twenty feet high and twenty-eight inches in girth a foot above the base.

POPULUS GRANDIDENTATA Michx.

Infrequent: Taupawshas Swamp; Shawkemo; boggy depressions along the northern border of Saul's Hills; Tom Never's Swamp; probably no trees seen over six or eight feet high.

* POPULUS TREMULOIDES Michx.

Occasional or frequent from the head of Long Pond across the island to 'Sconset and Polpis; small trees only.

Note. — It should be recorded that a few small trees of *Populus tremula* L., of Europe, occur scattered among the pines near Miacomet Pond. It would be a natural inference that these were accidentally introduced when the European pines were planted. But, if this be true, it is difficult to account for the small size and apparent youth of the poplars, the pines having been planted over thirty years ago. The largest of the poplars was less than ten feet high in 1907 and some were only a few feet tall. The same mystery attaches to the presence among the pines of some young trees of the Norway maple (*Acer Pseudo-platanus* L.) and a single small American chestnut [*Castanea dentata* (Marsh.) Borkh.] about ten feet in height. Among these pines also are a few small hickories which are certainly not native where they are established. A single small tree of *Populus tremula* was also found among the pines on the Surfside road which shelter as well scattered trees of the white ash (*Fraxinus americana* L.) and American elm (*Ulmus americana* L.), which are not known ever to have occurred on the island as native species.

* SALIX FRAGILIS L.

Introduced willows are established on Nantucket here and there along roadsides and meadows and about old farm lands. As a rule they have shown little ability to spread and some of the larger trees, of no great height in any case, which must have been

planted generations ago, maintain a solitary existence still. Younger trees of most of the species testify to some slight progress in natural increase but, except in the case of *Salix Smithiana*, none of the European species can be regarded as really naturalized.

What appears to be typical *Salix fragilis* occurs at a few places, but it is not common and seems to be only casually spontaneous.

* SALIX ALBA × FRAGILIS Wimmer.

Less uncommon than typical *Salix fragilis* and less doubtfully spontaneous, occurring at widely separated localities sometimes in out of the way places. The trees from different stations show considerable variation in the size and form of the leaves and the pubescence of the younger parts, some individuals evidencing more of their *alba* parentage, others more that of *fragilis*. No unequivocal examples of the hybrids *Salix decipiens* Hoff. and *Salix Russelliana* Smith were found. As a matter of local interest, the willows of this group should be studied in their flowering and fruiting seasons and receive careful determination.

* SALIX ALBA L.

Infrequent; typical *Salix alba* was collected at the border of a swampy thicket in Polpis. *Salix vitellina* L. was not observed.

* SALIX BABYLONICA L.

In a swampy lot on the south side of the town, in a situation where it would scarcely have been planted, a tree of medium size grew in 1899 and 1904 but had disappeared in 1906. This tree was perhaps the parent of two young trees, one about five feet high, observed in 1907 in low fields not far distant. A tree near the cockspur-thorn lot to the west of the town, growing with other introduced trees, was doubtless planted, as well as another tree near it, apparently a hybrid with *S. fragilis*.

* SALIX SMITHIANA Willd.

Salix cinerea × *viminalis* Wimmer.

This strongly characterized willow seems to be better adapted to the Nantucket environment than any other of the introduced species, and more than any other may be considered as definitely established. It is frequent in the general town region as well

as at outlying points and was met with in such uninhabited quarters as the "Woods" and east of Hummock Pond. It is well established on and below the bluff at 'Sconset, where groups of vigorous young trees were observed in 1904 and 1906, the larger being ten feet or more in height. In trees of this age the bark of the trunk and branches is smooth and pale greenish-gray, the younger twigs pale green and yellowish. That the tree was early planted in Nantucket is shown by some old trees in the outskirts of the town, in which the trunks are seamed and furrowed and gray with lichens. Not observed in flower or in fruit. The foliage of the Nantucket tree matches perfectly with that of Bebb's no. 55, Herbarium Salicum, grown at Fountaindale, Illinois, 1880.

Although this tree was undoubtedly introduced into Nantucket as a hybrid, and as such has maintained itself and increased its foothold, it is of particular interest to find that its parent species, *Salix cinerea* L. and *Salix viminalis* L., are also present on the island. A single tree of each was met with at points about six miles apart on opposite sides of the island. The detailed record of each follows.

* SALIX VIMINALIS L.

A single tree grows by a pond in a low field on the western side of the town. The tree is a very old one and is of large size for the species, the gnarled and sloping trunk thickly clothed with young shoots. It stands close to the rear yard of an old dwelling, where it may be supposed to have been originally planted, and it is referred to here only on account of its interest as one of the alleged parents of *Salix Smithiana*.

* SALIX CINEREA L.

A single thriving shrub of several stout stems about ten feet high on the border of Tom Never's Swamp, growing with *Salix Bebbiana* and *Salix petiolaris*. Bark of the stems smooth, and pale yellowish-gray. This shrub was first observed Sept. 15, 1907; on June 13, 1908, it bore many mature fertile catkins. Specimens collected agree closely with a sheet of Seringe's Swiss Willows in the herbarium of the New York Botanical Garden labeled as follows:

"*Salix cinerea* ð *obovata* Ser. rév. inéd.

S. acuminata Ser. saul. dess. n. 26–27.
S. acuminata obovata Ser. ess. 13.
S. aquatica Smith engl. bot. t. 1437, ex Borrer in litt.!
Berne, rives de l'Aar. 1824."

This species was not found in cultivation anywhere on Nantucket and its occurrence amid the native vegetation in the undisturbed surroundings of Tom Never's Swamp seems very noteworthy.

* SALIX PENTANDRA L.

Three trees 8 to 12 feet high in a low field below the "Cliff"; a group of more than thirty trees along the edge of a meadow near Lily Pond, the larger about eighteen feet high and smaller ones of a later generation among them. These trees had doubtless been planted originally at both stations and though now growing in natural surroundings have shown little disposition to become spontaneous. Some fertile catkins remained June 20.

* SALIX PURPUREA L.

Established at a few places in low meadows west of the town; a group of trees on the border of a damp field at 'Sconset.

* SALIX CORDATA Muhl.

Typical *Salix cordata* is found in abundance at Washing Pond, forming dense masses four to six feet high along the gravelly shore, the stems and branches often spreading and procumbent in the sand. It occurs also in Trot's Swamp. Not found in flower or fruit.

* SALIX RIGIDA Muhl.

Frequent in the neighborhood of Millbrook Swamp, sometimes forming close clumps eight or ten feet high; Trot's Swamp. Some fertile catkins remaining June 10.

SALIX DISCOLOR Muhl.

Except in the "Woods," where it is frequent, this is found only on the eastern side of the island; in the southeastern quarter from Tom Never's Swamp to Gibbs' Pond it is rather common and it occurs also in Polpis, inhabiting boggy spots along the northern side of Saul's Hills. A single tree at Watt's Run was fully twelve feet high and bore unusually large and thin, long-petioled leaves.

Certain specimens included here are perhaps referable to *Salix prinoides* Pursh.

* SALIX ERIOCEPHALA Michx.

Frequent or rather common in the same parts of the island where the preceding is found and often growing with it. Broad-leaved and narrow-leaved forms occur, one of the latter having the leaves and branchlets heavily invested with a soft ferruginous pubescence.

* SALIX BEBBIANA Sarg.

Frequent, occurring in the same localities as the two foregoing species. A few pistillate aments remaining June 13. On the border of Tom Never's Swamp a distinct-appearing form was met with, having unusually broad obovate leaves, densely velvety-pubescent on the lower surface and to some extent above.

* SALIX HUMILIS Marsh.

A single very typical shrub a little over three feet high met with on a dry spot at the border of Taupawshas Swamp. A few shriveled fertile aments accidentally persistent June 18.

SALIX TRISTIS Ait.

This low willow is frequent on the plains along the south side of the island east of Surfside, and large beds of it are found in the South Pasture. It was met with elsewhere only on the borders of Tom Never's Swamp and sparingly along the bluff at 'Sconset.

* SALIX SERICEA Marsh.

A single small shrub, about four feet high, in Gibbs' Swamp, Sept. 5, 1904.

* SALIX PETIOLARIS J. E. Smith.

Two low shrubs met with in Tom Never's Swamp, not far from the 'Sconset road, September, 1907 and June, 1908.

MYRICACEAE

* MYRICA GALE L.

A single strongly growing clump on the west side of Capaum Pond near the shore, covering a space about two yards in longer diameter. It is about two feet in height, and appears to be a

cluster of small shrubs but is in reality from a single root, the lower branches at first widely spreading on and below the surface of the ground.

MYRICA CAROLINENSIS Mill.

Everywhere an exceedingly common shrub, much dwarfed in dry open places, in low thickets becoming eight feet high.

COMPTONIA PEREGRINA (L.) Coulter.

Common over the plains and in the oak barrens, mainly on the southern and eastern sides of the island.

JUGLANDACEAE

HICORIA ALBA (L.) Britton.

Frequent in thickets, mainly in the northeast quarter of the island: Shawkemo; Quaise; Polpis; Pocomo; Squam; barrens west of Sankaty. Sometimes fruiting well when not over six feet high. No trees seen over fifteen feet in height. In full flower June 11; fruit nearly full size the second week of September.

* HICORIA MICROCARPA (Nutt.) Britton.

South of Wauwinet, in a dense thicket, Sept. 2, 1904—a single stout tree perhaps ten feet high with wide-spreading branches, the lowermost resting on the ground. Fruit abundant, definitely compressed, suborbicular in outline and mostly broader than long, the smaller, when dried, 18 mm. long and wide and 15 mm. thick, the larger 22 mm. long, 25 mm. wide, and 20 mm. thick. The bark of this tree was very pale and smooth like that of a beech, which seems to be a characteristic common to the three hickories native to Nantucket.

A single tree about seven feet high was found in a thicket in Pocomo, Sept. 21, 1907.

HICORIA GLABRA (Mill.) Britton.

Apparently rare, and certainly much less frequent than the mockernut. Found only in Shawkemo, and in Pocomo, fruiting rather sparingly. Fruit full size Sept. 11–21, 1907, obovoid-oblong or pyriform, the largest 28 mm. long, 24 mm. wide, 21 mm. thick. On June 9, 1908, it was much less advanced in foliage than was *Hicoria alba* growing with it and no aments

were developed although its companion species was covered with them.

In the dense thicket in Shawkemo, is a group of several trees certainly fifteen feet high, the largest twenty-eight inches in circumference a foot above the base; their bark is close and white like that of a beech, although a little broken and darker low on the larger trunks.

Note. — The shag-bark hickory [*Hicoria ovata* (Mill.) Britton] is mentioned by Mrs. Owen as having been found on Coskaty by Mr. W. L. Foster. The tree would be rather unexpected on Nantucket and a more detailed record seems to be needed. A few young trees, one about eight feet high, grow among the Miacomet pines, where they are certainly not native, and their presence there affords no better reason for admitting the species into the Nantucket flora than for accepting the chestnut as a Nantucket tree on the strength of a single small sapling found growing like the hickories among the pine trees.

BETULACEAE

CARPINUS CAROLINIANA Walt.

Admitted in Mrs. Owens' list; I did not meet with it.

CORYLUS AMERICANA Walt.

Frequent or common in dry thickets from the east side of the lower harbor to Shawkemo, Quaise, Polpis, and Squam. As a rule it does not fruit freely but sometimes, as on Rattlesnake Bank, it is very prolific.

CORYLUS ROSTRATA Ait.

Much more common and generally distributed than the foregoing, entering freely into the composition of the woody growth over the moorland and on dry exposed hillsides, and fruiting prolifically often when only six to twelve inches high. In low thickets in Polpis it reached a height of several feet and was loaded with fruit, some of the branchlets only five inches long bearing as many as ten well-developed nuts. In these the body of the fruit was small, 10–13 mm. long, and densely bristly-pubescent, the beak varying from straight to much curved and from 10 mm. to 25 mm. in length. On some of these low fruiting shrubs the

leaves were unusually small, sometimes only 3–5 cm. long throughout. In richer soils the shrub is taller with larger leaves and fruit, the latter becoming 18 mm. long with a stout beak 2–3.5 cm. in length.

BETULA POPULIFOLIA Marsh.

Rare near the town but well scattered locally over the island, mostly very small trees and none perhaps over 8 or 10 feet high: Shawkemo; Taupawshas Swamp; Quaise; Polpis; along the north side of Saul's Hills; Gibbs' Swamp; Tom Never's Swamp; west of Tristram Coffin's; head of Long Pond.

Note. — Some small stunted trees of the European birches, *Betula pubescens* Ehrh. and *Betula pendula* Roth, grow in a low, half-swampy thicket west of the town, together with several kinds of introduced oaks and native trees. This thicket adjoins the tract of land enclosed by cockspur thorns set out by William Henry Gardner about the year 1830, as recorded by Mrs. Owen (Cat. p. 25). The lot or thicket where these introduced oaks and birches now grow must have been utilized at one time as a sort of nursery, but either the trees were planted at a considerably later date than the thorn trees or else have been of very slow growth. Whatever their history, they have long been wholly neglected and have now united in a thick and tangled growth with the native trees and shrubbery, appearing as if they also were part of the natural vegetation of the region.

*ALNUS NOVEBORACENSIS Britton.

Two small shrubs grow on the western side of Capaum Pond and one on the south shore of Sachacha Pond; a single stout shrub grew just back of the shore on the east side of the lower harbor at Monomoy in 1904, but in 1907 was found to have disappeared.

The type of *Alnus noveboracensis* seems to be an aberrant form of a very common shrub which, on the one hand, almost unites with, or perhaps hybridizes with, *Alnus rugosa* (DuRoi) Koch and, on the other, approaches very close to *Alnus glauca* Michx. With the latter it seems to have been quite generally referred to *Alnus incana* (L.) Willd. of Europe, which, in my view, cannot properly be regarded as the same. The European shrub is, however, a

very near relative of our *Alnus glauca*, but less closely related to the obscurely known shrub here discussed.

In accordance with this understanding of *Alnus noveboracensis*, it is characterized by leaves of thickish texture, ovate to broadly obovate, mostly rounded but sometimes narrowed to the base and acute at the apex, slightly repand and dentate-serrate, dull green above, paler green beneath and rusty-pubescent on the veins or becoming densely ferruginous-pubescent over the entire lower surface as well as on the branchlets. This character is remarkably pronounced on some of the Nantucket material. *Alnus glauca* differs in more membranous leaves, oftener subcordate at the base and more sharply undulate-lobed, the lower surface pale glaucous-blue and glabrous or nearly so except on the larger veins. The bark of *Alnus noveboracensis* is somewhat intermediate between that of *Alnus glauca* and *Alnus rugosa*.

FAGACEAE

FAGUS GRANDIFOLIA Ehrh.

Uncommon and often quite hidden from view among the dense thickets where it is usually found. A small strongly established colony in Quaise; Shawkemo, east of Rattlesnake Bank; an occasional small tree in Pocomo; Watt's Run bank — a single old tree of clustered second growth trunks perhaps fifteen feet high, the tallest seen; one tree about twelve feet high on Coskaty; sparingly on both sides of Tom Never's Swamp, the stoutest tree measuring thirty-four inches in circumference below the nearly basal lower branches. A single tree in Quaise had developed a few imperfect fruits.

The leaves vary widely in shape and degree of dentition as well as in pubescence — from ovate with definitely cordate base to lanceolate-oblong with narrowed base and from nearly glabrous with silky-pilose hairs on the veins beneath to thinly silky-pilose on the upper face and densely soft puberulent over the entire lower surface without any silky hairs; the margins are sometimes thickly pilose-fringed. These wide variations, almost in their extreme phases, may sometimes be found in leaves from the same tree.

Note. — A single slender sapling of the American chestnut, *Castanea dentata* (Marsh.) Borkh., grows in an opening among

the pines near Miacomet Pond; on June 17, 1908, it was about ten feet high. (See note under *Populus tremula*.)

QUERCUS COCCINEA Wang.

A few small trees occur among the pines south of the fair grounds and a single tree at the edge of the pine grove on the Surfside road. On June 12, 1908, this tree was less than ten feet high, the upper parts dead, but, near the base, bearing many widely radiating prostrate branches closely pressing the ground and twelve to twenty-two feet in length; on some of these the terminal branchlets were so slenderly elongated as to appear trailing and theabundant foliage of erect or ascending branchlets gave the appearance of a low growth of scrub-oak completely surrounding the tree.

This oak was seen nowhere else than at the two points mentioned and it seems very doubtful if it is native to the island.

QUERCUS VELUTINA Lam.

Of the few arborescent oaks native to Nantucket this and the white oak are still common enough to show that they must have been among the prevailing trees before the wooded parts of the island were deforested generations ago. Both species usually occur together, mostly about the borders of dense thickets or surrounded on all sides by an almost impenetrable growth of low trees and shrubbery. In such situations they are often noticeable from a distance rising above the surrounding growth, although rarely more than eight or ten feet in height. Here and there, as in Quaise, Polpis, Pocomo, about Tom Never's Swamp, and on Coskaty, they are of larger stature, reaching a height of fifteen or twenty feet, and unite with the sour gum, sassafras, wild cherry, red maple, and other trees to form patches of low woodland. The stoutest black oak seen was in Tom Never's Swamp and measured thirty-six inches around near the base.

On Coskaty is a considerable tract of low, thickety, almost impenetrable woodland largely composed of this oak, compact heavily foliaged trees, which bear abundant fruit. Here the species separates into two remarkably diverse forms, which flourish side by side. One is the ordinary form of the tree having leaves with broad lobes mostly wider than the often shallow sinuses. Its companion form might easily be mistaken for the scarlet oak. The

leaves are even more deeply cut, with the sinuses wide and deep, often much wider than the lobes, leaving the lamina along the midrib narrowed to a width of only 0.8 to 1.5 mm. These leaves were mostly wider than long, the median lobes divergent and spreading, about twice the width of the narrowed basal pair, widely dilated towards the end into divergent, triangular, entire lobes, the narrowed basal part often elongated and mostly 1 to 1.5 cm. wide. Many of these leaves as late in the season as the middle of August, with their petioles and the branchlets, were clothed with a fine stellate scurfiness; others were glabrous except in the axils of the primary veins.

* QUERCUS PAGODAEFOLIA (Elliott) Ashe.

Near Quaise Point, June 11, 1908—a single tree in full flower growing in a low thicket. The tree was about twelve feet high and twenty-four inches around two feet above the base; the lowest branches, over six feet above the ground, were nearly horizontal and their widest spread about ten paces. The tree stood in an opening into the thicket and much of the bark of the trunk had at one time been destroyed, apparently by cattle; the wound had healed but the trunk had been nearly girdled and the living bark on one side reduced to a strip only three inches wide.

Doctor N. L. Britton has joined me in a study of the leaves of this tree and we have reached the conclusion that it can be referred to no other species than *Quercus pagodaefolia*. The leaves are not in all respects precisely identical with typical examples of *pagodaefolia* from the southern states, their lobes being often less acuminate and entire and the pubescence of the lower surface less firmly persistent and of a more yellowish tinge; but the form of many of the leaves is exactly that of the southern tree and quite unlike that of any of our northern oaks, the lobes being triangular-lanceolate and wholly entire. Other leaves approach in form those of the black oak but differ in the lobes being more narrowed towards the ends and more entire, the basal pair spreading as widely as the median ones, or nearly so, instead of being conspicuously shorter.

In Britton's Manual the range of *Quercus digitata* (Marsh.) Sudw. is given as extending north to Long Island. This northern limit was based on a single tree found by me near Hempstead,

which is the same as the Nantucket tree and should now be referred to *Quercus pagodaefolia*. It may here be also recorded that an individual of precisely the same kind of tree was observed at Fair Haven, Mass., June 6, 1908; this tree was some 25 to 30 feet in height and about a foot in diameter near the base.

QUERCUS ILICIFOLIA Wang.

Abundant on the eastern side of the island, in many places forming extensive thickets of so dense and rigid an entanglement as to be almost impassable. Fruiting abundantly.

QUERCUS ALBA L.

Rare on the western side of the island; frequent or locally common in thickets on the eastern side in the section east and northeast of a line drawn from Quaise to Tom Never's Swamp. The trees are mostly 6 to 10 feet in height, but become at least fifteen feet high in low swampy woods in Polpis. No fruit was found.

The stoutest native tree of any kind met with on the island was a white oak in a dense thicket in Quaise which measured 40 inches in circumference a foot above the base.

* QUERCUS STELLATA Wang.

Met with at four stations on the eastern side of the island. The nearest of these to the town is about two and a half miles out on the Wauwinet road, where there is a group of straggling trees covering a space ten or twelve paces in longer diameter, the trunks mostly ascending and the tallest less than ten feet high; these were a second growth from old stumps that had been cut long before. They bore abundant immature fruit, Sept. 11, 1907. A single tree about six feet high was found in 1906 in Saul's Hills west of Altar Rock Hill, and a tree of about the same height in Tom Never's Swamp, less than a half mile southeast of 'Sconset. A close group of four trees less than ten feet in height was discovered in 1899, about a mile northwest of 'Sconset. In June, 1908, these trees seemed to be dying; the ground about them had been much trampled by cattle and the trunks much abraded; the largest trunk was 19½ inches around a foot above the base.

QUERCUS PRINOIDES Willd.

Common on the eastern side of the island in the same territory as *Quercus ilicifolia* and often associated with it. Fruiting freely. Staminate aments June 13.

*.QUERCUS PRINOIDES RUFESCENS Rehder.

Met with at many points always in association with *Quercus prinoides* and *Quercus ilicifolia*; near Sankaty Head; Tom Never's Swamp; Plainfield; between the fourth and sixth mile along the railroad.

While there seems to be nothing in the habit or aspect of this oak to set it apart from typical *Quercus prinoides* it may always be readily distinguished by reason of its puberulent branchlets and the densely pubescent veins on the under surface of the leaves; the pubescence is also usually of a slightly fulvous tinge. Notwithstanding this greater pubescence below of the mature leaves, the unfolding leaves are commonly much less pubescent than are those of typical *Q. prinoides* of corresponding age. In general the leaves of *rufescens* are, as Mr. Rehder has pointed out, more obovate and less gradually narrowed to the apex and perhaps, also, more sharply undulate-lobed, but these differences, although often well-defined, are not at all constant.

On Long Island *rufescens* is common, as on Nantucket, inhabiting tracts where *Quercus prinoides* and *Quercus ilicifolia* are common also. In September, 1908, the fruit was collected at two places and presented well-defined differences from that of *Quercus prinoides* obtained at the same time, being considerably larger with a much deeper cup, more rounded below, and often covering more than half the acorn; the scales of the cup are also paler in color and more densely tomentulose-felted as well as longer and more narrowed to the apex, and form a perceptible erect fringe around the margin. The acorns measured when dry 15 mm. long by 12 mm. thick, the cups 12–15 mm. wide by 10 mm. deep; in *Q. prinoides* collected with it the acorns were 10–12 mm. long by 9–11 mm. thick, the cups 10–12 mm. wide by 4–6 mm. deep. The fruit of many of our oaks is, however, remarkably variable, and it is yet to be ascertained whether the differences here described are in any way constant. The actual status of this newly described

oak remains to be determined. It may be merely a phase of *Quercus prinoides* or it may be a distinct although very closely related species.

Note. — Several species of introduced oaks, some appearing like native trees, grow in the long-neglected lot, near the present Benjamin Coffin farm west of the town, which has already been referred to as a station for the European birches, *Betula pubescens* and *Betula pendula.* These oaks are the following, there being from one to several small trees of each species: *Quercus bicolor* Willd.; *Quercus rubra* L.; *Quercus palustris* Muench.; *Quercus Robur* L.

ULMACEAE

* ULMUS AMERICANA L.

A few small scattered trees have sprung up among the pines on the Surfside road, where they appear to be wholly spontaneous. Two trees estimated to be about thirty feet in height grow together on the edge of Trot's Swamp on the north side. This part of the island is now quite uninhabited and these trees appear like part of the native vegetation, but they are not far from a long-abandoned farm, and some trees of *Populus candicans* near them, of considerable size, are unmistakable evidence of man's handiwork in generations gone. All of these elms are the form with pubescent branchlets with the leaves very scabrous on the upper surface.

Elms were early planted in the town, where they have thriven well and become a very beautiful feature of some of the main streets.

Note. — Some small trees and shoots of the European elm (*Ulmus campestris* L.) are found along the road to Surfside, beyond the outskirts of the town, but they are only sparingly spontaneous about trees that must have been originally planted.

MORACEAE

* HUMULUS LUPULUS L.

Along an old roadside fence and in an adjoining field west of the town; also on Crooked Lane, and at several places near cultivated ground, where it is less clearly spontaneous. First noticed in a wild state in 1906.

* HUMULUS JAPONICUS Sieb. & Zucc.

Found in 1899 trailing all over a rubbish-heap by a roadside north of the town; not seen again until 1907, when a single plant in full flower was observed Sept. 16, in waste ground less than a mile south of the town.

CANNABIS SATIVA L.

Two instances of the occurrence of this species in the town are recorded by Mrs. Owen. I did not meet with it.

Note. — A thick cluster of the white mulberry (*Morus alba* L.) about four feet in height, from two main shoots, grew on Sept. 11, 1907, on the edge of a field near a barn on the Wauwinet road about two miles from the town. The tree may have been originally planted at or near this station and the species is noted here only for the purpose of a record in the case of a tree which has shown a readiness to become naturalized in some parts of the country.

URTICACEAE

URTICA URENS L.

Mrs. Owen has reported this nettle as rare at the time her list was published in 1888, but a not uncommon garden weed fifty years earlier. I saw nothing of it.

* URTICA LYALLII Wats.

A vigorous patch in full flower growing by a fence near waste ground in 'Sconset June 13, 1908.

* ADICEA PUMILA (L.) Raf.

Rare, but growing in abundance in an open sphagnum bog in Shimmo valley; also in Watt's Run bog; in full flower Aug. 29, 1904 and Sept. 11, 1907.

BOEHMERIA CYLINDRICA (L.) Willd.

By the borders of several ponds and in low thickets west of the town; Trot's Swamp; Polpis; Watt's Run; in full flower Aug. 14, 1906.

* BOEHMERIA SCABRA (Porter) Small.

Rather common in weedy meadows and wet places across the northern side of the island from Long Pond to Polpis. In full flower in early September.

Typical examples appear very distinct from *Boehmeria cylindrica* but the two plants seem to run together and may prove to be only extreme conditions of one species.

PARIETARIA PENNSYLVANICA Muhl.

Mrs. Owen's list records "some half dozen" plants found in 1879 on Coatue "in beach sand close to a boulder near the water's edge."

SANTALACEAE

COMANDRA UMBELLATA (L.) Nutt.

Very common over the moorland, especially in the southeast quarter of the island. Some plants still in flower June 13.

A statistical criterion for species and genera among the bacteria*

C.-E. A. Winslow

The existence of an almost infinite number of minute variations in many groups of bacteria has so far almost nullified any attempt at a natural classification. Isolated bacterial cells, lying free in a liquid medium, are exposed in a high degree to the direct effect of the environment; and the extent to which virulence may be exalted or attenuated shows how easily they respond to such influences. The absence of the sex process probably magnifies any tendencies to variability. Amphimixis may well serve, as Weissmann holds, to promote minor variations; but on the other hand it is reasonable to believe that it checks more extreme deviations from the mean. Among asexual organisms, every variation that arises is preserved intact until acted on by some modifying cause. Finally, the rapid multiplication of the bacteria offers an exceptional opportunity for the action of selective influences. The immense number of generations which succeed each other in a short space of time makes boundary lines as shifting as they would become among the higher plants if a dozen geological periods were considered all at once.

In certain groups of the bacteria, among the Coccaceae for example, and in the group of *Bacillus Diphtheriae*, the inconstancy of characters is specially marked and it is possible by appropriate laboratory experiments to modify profoundly such important metabolic properties as acid-production and chromogenesis. Other groups, like that of the aerobic spore-formers, appear to be in relatively stable equilibrium. Even where the characters of any given strain are fairly constant, classification is often complicated by the fact that an almost infinite series of minutely differing strains may be found, each apparently constant under existing conditions but together forming a continuous series connecting widely separated types.

* Read before Section G of the American Association for the Advancement of Science at the Baltimore Meeting, December 31, 1908.

The result of this condition of affairs is that systematic bacteriology has almost fallen into desuetude. After a brave beginning in the way of describing bacterial species the conviction gradually gained ground that of the making of species there is no end. Aside from the forms which are recognized by their association with well-defined diseases, there are hardly a score of bacteria that can be distinguished with any certainty among the hundreds which have been already described. Time and industry alone would be needed to produce as many thousands as there are now hundreds of paper species; but the condition of affairs would only be still more hopeless.

Refuge from the multitude of varieties has been sought, on the one hand, by ignoring all minor differences and massing the bacteria into a few main groups; and, on the other hand, by a frankly arbitrary schematic arrangement of cultures according to their plus-or-minus reaction in a few standard media, decimal numbers being used for the description of each combination of possible reactions. Neither of these expedients is very satisfactory. The first ignores real differences of much practical as well as theoretical importance. The second method, while convenient for the cataloguing of descriptions, only obscures the natural phylogenetic relationships of bacterial types. Organic individuals have not been created in symmetrical groups, differing in the presence or absence of character *A*, each group including two sub-groups, respectively possessing and lacking character *B*. They have been developed along irregular and complex lines, and are now related in family groupings of infinitely various kinds and degrees.

There is one method, and apparently only one, which promises to answer the puzzling question of bacterial relationships. This is the statistical method. If attention be given, not to the individual, but to the group, and if certain characters are quantitatively measured in a considerable series of cultures and statistically analyzed, order begins to emerge from chaos. Almost every degree of acidity or gelatin liquefaction may be found in some individuals; but the greatest number of strains group themselves about well-defined centers. The curve of frequency plotted for any character shows certain modes which are the types about which the bacteria as a group are varying. Furthermore, if sev-

eral distinct characters are compared, it will frequently appear that on the average certain properties are correlated with each other and generally vary together. As mountain tops occur in ranges, so the peaks on the curve of frequency for any single bacterial character are grouped together, by the study of other characters, into larger complexes. Major and minor groups may rightly be considered as constituting genera and species among the micro-organisms. They are not separated by boundary lines but are fixed rather by the centers about which they group themselves. They are genera and species, characterized, not by the description of individual strains, but by the frequency of occurrence of a considerable series of such individuals.

This method of statistical classification is by no means novel. Ever since Quételet and Galton began to apply the statistical method to the solution of biological problems it has been recognized that species and varieties could be more or less satisfactorily fixed by a study of frequency of distribution. Davenport and Blankinship (Science II. **7**: 685) even went so far as to suggest a definite numerical criterion of a species, founded on this basis. According to their suggestion, if a bimodal curve is obtained, the ratio of the ordinate of the lesser mode to the minimum ordinate in the depression between the modes, may be considered as an index of the isolation between the two races. If this ratio is over two, the modes represent species; if under two, varieties. The numerical criterion fixed by these authors may be criticized as somewhat arbitrary. The general principle is sound, however, and has yielded good results in many fields. Notably in the study of the races of man the statistical method has proved of the highest service. Curiously enough, among the micro-organisms, where some method of this sort is most urgently needed, statistical study has until very recently been wholly lacking.

At the Massachusetts Institute of Technology we have been for some years working on the classification of the family Coccaceae, one of the most difficult groups of the bacteria, by this general method. We collected five hundred different strains of cocci from various sources, earth, water, air, and the normal and diseased human body. After some considerable preliminary study eleven characters were fixed upon as having probable systematic importance

and as adapted to definite quantitative measurement. When the results obtained were analyzed from the statistical standpoint, groups and subgroups of various grades were obviously apparent; and it was possible to draw up on this basis a general outline of a classification for the group, which appears to correspond to true phylogenetic relationships (Winslow, C.-E. A., & Winslow, A. R., Systematic Relationships of the Coccaceae; New York, 1908). In the first place, two major divisions or subfamilies were distinguished, one saprophytic and the other parasitic. The cocci from the human body generally occurred in chains or small irregular groups of cells, stained by the Gram stain, formed a meager or only fair surface growth on media, produced acid in carbohydrates, and showed no pigment or a white or orange one. The cocci from earth and water, on the other hand, occurred in large cell groups or packets, decolorized by the Gram stain, grew well on solid media, failed to ferment carbohydrates and produced a red or yellow pigment. Each character was sometimes found in the group where it did not normally occur, but on the whole the average correlation was very strong. Within each subfamily several groups of a second grade of individuality were found, marked by the association of a smaller number of characters than the subfamilies, but still defined by the correlation of several independent properties. These were called genera. Finally, within the genera, species were defined by the distinct centers of variation which were manifest for single independent characters, such as the liquefaction of gelatin and the reduction of nitrates.

Curiously enough, while we were at work upon the relationships of the family of the Coccaceae as a whole, Andrewes and Horder in England were applying almost exactly the same principles to the classification of the subtypes included in the genus *Streptococcus*, a genus which is so marked in its characters that it has been one of the few groups of the Coccaceae long recognized as a result of common observation. What species should be included in the genus *Streptococcus* has been the subject of long and fruitless debate; and the "Vielheit" or the "Einheit" of the *Streptococci* seemed an insoluble problem. Andrewes and Horder, however, by studying the numerical frequency of occurrence of various forms distinguished seven type centers which they could properly

recognize as species (Lancet **1906**[2]: 708). Their work greatly extended ours, as we had worked scarcely at all on the particular genus with which they dealt. The combined effect of the two investigations is to emphasize strongly the value of the statistical method in bacterial classification; and there seems no reason why the same principles should not be of similar value in the systematic study of algae and fungi and Protozoa and other simple and variable forms.

Among other things that these studies emphasized is the importance of physiological differences in bacterial classification. Systematic bacteriology has been greatly retarded by the undue emphasis laid on morphological characters. Reasoning from analogy with higher plants, many bacteriologists have refused to base generic distinctions upon anything but morphological differences. As there are very few morphological differences in the group, there has been no rational generic classification. The distinction between physiological and morphological characters is merely a superficial one. Both are presumably due to chemical modifications of protoplasm; and there is no reason to suppose that a protoplasmic property which manifests itself in the size and arrangement of parts is any more fundamental than one which manifests itself in the ability to utilize a certain food stuff. It is precisely along the lines of metabolism that the bacteria have attained their extraordinary degree of differentiation. The higher plants have developed complex structural modifications to enable them to absorb food materials of certain limited kinds and to utilize the sun's energy in building them up into protoplasm. Meanwhile the bacteria have maintained themselves by acquiring the power of assimilating simple and abundant foods of the most varied sorts. Evolution has developed gross structure in one case without altering metabolism; it has produced a diverse metabolism in the other case, without altering gross structure. There is as wide a difference in metabolism between the *Pneumococci* and the nitrifying bacteria as there is in structure between a liverwort and an oak. So-called physiological differences are quite as important in one case as so-called morphological differences in the other.

The characters which are of prime systematic importance will naturally vary according to the particular group of bacteria which

is under consideration. One family or genus may have differentiated along the line of carbohydrate fermentation; another may have divided into groups adapted to a parasitic life on particular tissues of the human body, like the *Diplococci;* in a third, obvious differences in reproduction may have arisen, as in the anaerobic spore-formers. This is one reason why the conventional bacterial classifications are inadequate. Migula (System der Bakterien, II., Jena, 1900) and Chester (A Manual of Determinative Bacteriology, New York, 1901), for example, recognize only five morphological genera among the Coccaceae and divide them all into dichotomous classes by the same arbitrary plus-and-minus tests. Such an arrangement is very far from representing the complex facts of relationship. A difference of great systematic importance in one group may be valueless in another. In each group of the bacteria as many reactions as possible must be examined with an open mind in order to determine which are of systematic importance. In many groups the most helpful properties which mark their characteristic differentiation may be biochemical reactions not yet studied at all. It was the careful examination of fermentative power in various carbohydrate media by Gordon and his colleagues that made the classification of the *Streptococci* possible and it is quite probable that a similar detailed knowledge of the saprophytic *Micrococci* will be acquired only by the application of tests not now at our disposal.

The tests chosen for systematic study of the bacteria should, as far as possible, be susceptible of definite quantitative measurement. A great deal of the earlier confusion which has surrounded the subject has been due to descriptions of colony-formation, etc., which were expressed in terms wholly dependent on the personal equation of the author. For statistical study, records should, if possible, be capable of expression on a numerical scale. Where this is not feasible, as in comparing pigments of different hues, the observations may be divided into classes, defined as closely as possible by comparison with known standards. The cultures studied should include a considerable series of the particular group studied; and it should represent a wide variety of habitats, as the bacteria are usually closely adapted to their particular environment.

When the observations of several hundred cultures are finally

obtained and tabulated, the first important thing is to determine the major groups included in the series. This may be easily done by a general study of the correlation of different characters, without any elaborate mathematical methods. In our work on the Coccaceae we constructed a correlation table for each pair of characters and noted the general coincidence of one with the other.

It must be remembered, in estimating the importance of the occurrence of correlated characters, that their common presence may be due to one of two causes. The characters may be correlated simply because ancestral forms developed them both, under the action of independent causes. Or, on the other hand, the properties in question may not be really independent but subtly bound up in the physiological balance of the organism so that a modification of one leads to a corresponding change in the other. In either case profound modifications which have altered the whole center of gravity of the organism may rightly be considered of generic or family rank.

Within the genera, specific types may be defined by variations in single or subordinate characters.

The final test as to whether two related organisms deserve recognition as species, or are only variants from a single type, must be made by an examination of the curve of frequency for the character on which their identity is supposed to rest. If there is a single center of frequency of occurrence it is fair to consider that the type is a simple one, however variable it may be. Thus Goodman (Journal of Infectious Diseases **5**: 421) has recently made a study of the *B. Diphtheriae* group, which indicates that widely differing strains of these organisms belong to a single type. If on the other hand two distinct modal points indicate two separate centers of distribution each may well receive a specific name. Intermediate cases will of course be found, in which the curve of frequency has two peaks separated only by a shallow trough. In such cases Davenport and Blankinship's criterion, to which reference has been made above, may be helpful; although any such arbitrary standard is likely to be modified by enlarged knowledge.

It may be maintained with reason that genera and species of bacteria defined by the statistical method will not be invalidated by the discovery that the characters on which they are based may be

modified, either experimentally or under natural conditions. Among the flowering plants the study of a long series of specimens from habitats separated in space or time often tends to make the boundaries between species almost indistinguishable. If we could modify and control the environment of these higher forms through countless generations, as we do in the case of the bacteria, there can be little doubt but that we could transmute one form into another. Yet for practical convenience, and in recognition of the existing preponderance of certain types, we recognize them as constituting species. So among the bacteria we may reasonably hold that even mutable types in certain unstable groups are deserving of systematic recognition.

It is a curious fact that some of the most variable characters among the Coccaceae, chromogenesis and reaction to the Gram stain, for example, proved to be most strikingly correlated with the modifications of other powers, associated respectively with the parasitic and saprophytic habitats. Among the higher plants the modifications due to environment are comparatively superficial. Among the plastic unicellular organisms on the other hand the adaptation to parasitic life, for example, may produce profound changes, which warrant generic rank. Among the more complex plants and animals, indeed, the same conception of purely environmental types is gaining ground. It is not in connection with bacteria that Jordan and Kellogg (Evolution and Animal Life, New York, 1907), speak of "Ontogenetic species held for a number of generations true to a type simply because the environment, the extrinsic factors in the development of all the individuals in these successive generations, are the same."

The main points which I have tried to emphasize as essential to a rational natural classification of the Schizomycetes may be briefly summarized as follows:

1. In groups like the bacteria and perhaps some classes of the fungi, which have differentiated along physiological rather than morphological lines, differences in metabolism may have the same systematic importance given to gross structural differences in other groups.

2. The characters of greatest systematic importance, whether morphological or physiological, vary in each particular group of

bacteria, according to the lines followed in recent evolution. The classificatory value of a particular character must be determined for each group by a preliminary survey of its relationships.

3. The most satisfactory method of studying the systematic relations of these simple and variable forms is by obtaining quantitative measurements of a number of characteristic properties in a large series of individuals and by statistical analysis of the results.

4. Generic names may conveniently be given to the larger groups of organisms having several apparently independent properties in common, as indicated by correlation between different measurements. Generally these groups will be found associated with certain definite habitats.

5. Specific names may be reserved for the smaller groups, characterized by variations in single uncorrelated properties. Each strongly marked mode on the curve of frequency, marking a type center about which variations are occurring, may be taken as a species.

6. Genera and species defined in this manner by frequency of occurrence are not invalidated by the variability of the organisms belonging to them. Stable or unstable, they are definite realities, and their recognition makes it possible to arrange the bacteria in convenient natural groups which approximate their true phylogenetic relationships.

BIOLOGICAL LABORATORIES,
MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
BOSTON, MASSACHUSETTS.

New hybrids in Dryopteris

RALPH CURTISS BENEDICT

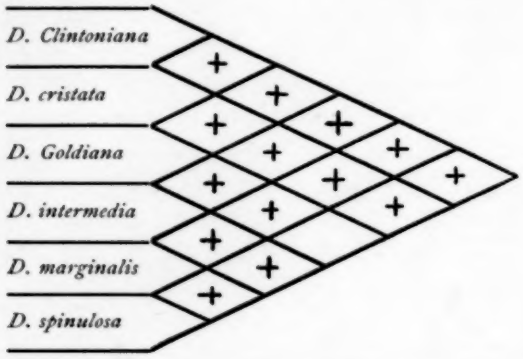
Fern students in the eastern United States can hardly expect to find new species in so well-known a region but the discovery that certain native species may hybridize, and that under favorable conditions they do so rather frequently, as in the case of *Dryopteris cristata* × *marginalis*, opens up a field for study which is as yet very little known. There is always the chance that a new one may be found, and there are problems connected with the variation and the reproduction of the known hybrids which are yet to be worked out. The subject is not a simple one. Indeed a thorough knowledge of the plants can be obtained only after much experimental research and laboratory investigation, but field observers can render service by collecting these plants and recording the facts of their distribution, habit, and habitat. Furthermore, the intensive study needed in identifying the hybrids will add greatly to our knowledge of the parent species.

The hybrids so far reported for eastern United States number eleven and are comprised in three genera. *Asplenium* has two, *A. Ruta-muraria* × *Trichomanes*, and the bigeneric hybrid *A. platyneuron* × *Camptosorus rhizophyllus* (*Asplenium ebenoides* Scott). The latter is especially interesting as the first of our native hybrids to have its origin experimentally demonstrated.* The remaining hybrids are found in the genus *Dryopteris*, which, in this region, contains six species whose habitats are frequently associated, and which seem to hybridize more or less readily with each other. The species are *Dryopteris Clintoniana*, *D. cristata*, *D. Goldiana*, *D. intermedia*, *D. marginalis*, and *D. spinulosa*. Given six units, the number of possible combinations, taking two at a time, is fifteen, and we may expect to find that number of hybrids in this group. The following diagram, adapted from one used by Dr. Ezra Brainard in his studies of violet hybrids, shows

* Bull. Torrey Club 29 : 487–495. *f.* 1–7. 1902.

the present status of our knowledge of these plants. The known hybrids are marked with a cross.

The first of these to be described was *D. cristata* × *spinulosa*, which has been recognized in Europe since 1855, but in America has only recently been differentiated by Dowell * from *D. cristata* × *intermedia*, long known as *D. Boottii*. The first typically American hybrid to be described was Davenport's *D. cristata* × *marginalis*, which had been discovered and recognized by Raynal Dodge.



Following this came the hybrid between *D. marginalis* and *D. spinulosa*, described as *D. pittsfordensis* by Miss Margaret Slosson, whose experimental production of the Dodge hybrid and of *Asplenium platyneuron* × *Camptosorus rhizophyllus* has furnished a definite basis for a further study of these plants. Dr. Philip Dowell, the next in the field, besides recognizing *D. cristata* × *spinulosa* as an American plant, gave *D. Boottii* its proper name (*cristata* × *intermedia*), and described the corresponding *Clintoniana* cross, *D. Clintoniana* × *intermedia*, and three interesting *Goldiana* hybrids.† In addition to these, the hybrids described in the present paper and one between *Clintoniana* and *marginalis* to be described by Miss Slosson, and two others which are held for further study, bring the number known in this group to fourteen, leaving only the one between *Goldiana* and *spinulosa* yet to be found.‡

But there is no apparent reason why hybrids should not occur

* Bull. Torrey Club 35: 135–140. 1908.

† *Loc. cit.*

‡ Since this was written, material has been seen which appears to be this hybrid, and a description of it is included below.

in genera other than *Dryopteris*. Indeed, several have been reported for *Asplenium*, principally in Europe, and in *Polystichum*, and we may expect such genera as *Athyrium* and others which contain groups of similar associated species to produce crosses when conditions are favorable.

The fern hybrids known at present are nearly all from temperate regions, but the damp forests of the tropics with their numerous related species and multitudes of individuals would seem to furnish ideal conditions for inter-specific crossing, and it is possible that many plants described as species are really hybrids. But as is noted hereafter, the determination of a hybrid requires a most thorough knowledge of the parent species and all their variations, not only in the herbarium but especially in the field, and until the intensive study necessary to the attainment of such knowledge can be given, the classification of the different forms as species is the only satisfactory method of treatment.

Fortunately for the study of our native hybrids, one of the commonest of them, *Dryopteris cristata* × *marginalis*, has been experimentally produced, so that its origin is undeniable, and we are justified in assuming that plants which possess the same general characteristics and are similarly intermediate between two known species are also hybrids. A knowledge, therefore, of the general features of *D. cristata* × *marginalis* is important in the study of other *Dryopteris* hybrids. These features may be considered under three heads: (1) intermediate character, (2) sterility, abnormality, and greater vigor, and (3) distribution.

1. The intermediate character of *D. cristata* × *marginalis* led Dodge and Davenport to suspect its hybrid origin, but a study of numerous specimens of the hybrids shows that they are not all intermediate to the same extent. As one might expect, some plants show greater resemblance to one parent and some to the other. It is interesting to note also that an occasional reverting frond is found which resembles one parent much more than the other fronds on the same plant. In determining whether a suspected plant is intermediate or not, it is necessary to take into consideration several characters.

A. The general habit of growth often attracts the attention before the more easily described diagnostic characters can be seen

at all. This, of course, is likely to be especially marked if the parent species differ markedly in habit. But even in such cases one parent may predominate over the other to such an extent that the hybrid may be identified as one of the parent species.

B. The final tests depend then on an examination of the more critical characters and the value of these characters seems to vary inversely with the size of the part of the plant examined. For example, *D. Goldiana* and *D. Clintoniana*, which are often very similar in general leaf-form, differ in the shape and cutting of the pinnae and of the pinnulae, in the stipe-scales, and in the cell-structure of the indusia. The characters of the indusia have been very little used in fern classification, but they frequently furnish valuable tests in determining the identity of a given specimen, and are particularly useful in the class of ferns treated in this paper. *Dryopteris Goldiana* and *D. marginalis* have characteristic indusia, as can often be determined from a gross examination, and in cell-structure, these can easily be distinguished from the indusia of *D. Clintoniana* and *D. cristata*, and those of the spinulose ferns. The last-mentioned have indusia of the same general structure as have *D. Clintoniana* and *D. cristata*, but are much thinner, and in the case of *D. intermedia* are invariably glandular, a character which distinguishes this fern from all the other species of *Dryopteris* that occur in association with each other in this region. *D. dilatata*, which is occasionally glandular, is a fern of high altitudes in this latitude and need not be considered under ordinary circumstances, although where it does occur with other species, hybrids should be looked for. A hybrid between this fern and *D. Filix-mas* is already known in Europe. But aside from this possible exception, it seems safe to say that the presence of glandular indusia on a suspected plant indicates *D. intermedia* as one of the parent species. From what has been said, it will be seen that a primary requisite in the study of fern hybrids is a thorough knowledge of the parent species, not only of the general synoptical characters, but also of the more minute differences.

2. Sterility, greater vigor, and abnormality. The material of *D. cristata* × *marginalis* and also of the other plants considered to be hybrids, is almost uniformly sterile. This sterility manifests itself either in the form of abortive undersized sporangia, or, if the

sporangia attain full size, in abnormal, granulated spores. Only in a few mounts out of scores examined have any normal spores been seen, and in these few instances their presence may have been accidental. But as in hybrids generally, it is probable that the sterility is relative rather than absolute, and we may expect occasionally to find fern hybrids capable of reproducing by spores.

Correlated with the sterility is usually a greater vegetative activity. This may be expressed merely in the development of larger plants, or it may take the form of abnormal fronds in which some parts are greatly expanded while others remain of ordinary size or even abort. Such irregular fronds are of frequent occurrence in *D. cristata* × *marginalis* but are by no means invariable, as many plants are found in which all the fronds are symmetrical. Occasionally this irregularity is so marked as to obscure the general resemblances of the suspected hybrid, and in such cases, unless the identity of the parent species can be established beyond doubt by means of critical characters, a positive identification may be impossible. In this connection it should also be noted that irregular plants which are to be explained as due to ecological conditions or as sports rather than as hybrids, are not unusual.

3. In distribution, *Dryopteris* hybrids are rare or occasional in damp woods with the parent species. The general occurrence of hybrids has been doubted because of the presumed difficulty of the actual process of hybridization but the presence of numerous plants of *D. cristata* × *marginalis* in some especially favored localities is evidence that the difficulty may not be as great as has been imagined. The immediate presence of the parent species is not a necessity since fern plants are often long-lived and the greater vigor of the crosses might render them resistant to conditions sufficiently adverse to destroy the parent species.

Following are descriptions of hybrids already noted as new:

Dryopteris Clintoniana × **spinulosa** hyb. nov.

In habit resembling *D. Clintoniana*, the rootstock horizontal, the fronds of two sorts: (1) juvenile and sterile, and (2) mature and usually soriferous: mature fronds tall, about 70 cm. long; stipe light yellow above, dark brown below, clothed with thin pale brown scales; lamina oblong, acuminate, 30–40 cm. long, by 16–20 cm. broad, once pinnate, the rachis distinctly winged in the upper fourth;

pinnae oblong and sessile above, to deltoid and stipitate below (lowest pinnae 7–10 cm. long by 4–6.5 cm. broad), mostly deeply pinnatifid half way to the midveins or more except in upper fourth of the lamina, nearly pinnate below but with winged midveins; pinnulae oblong to oblong-lanceolate, straight or slightly falcate, somewhat acuminate, up to 4 cm. long by 1.6 cm. broad, entire, spinulose-dentate or pinnatifid (half way to midveins on basal pinnae), bases unconstricted above (upper third of lamina), to deeply constricted below (nearly to the midvein in basal pinnae), the lobes and teeth mostly inflexed: sori rather scant, midway between the margins and the midveins; indusia thin, glabrous: juvenile fronds low-spreading, the laminae oblong, about half as broad as long.

Type in the Underwood Fern Herbarium, New York Botanical Garden: *Benedict 68*, from Cornwall, Conn., July, 1907. Collected also by E. Brainerd at Middlebury, Vt., June, 1879, and July, 1908; by E. J. Winslow at Barton Landing, Vt., Aug. 16, 1908; and by Ph. Dowell *3928* (in part), at Suffern, N. Y., July 23, 1905.

As might be expected, this fern resembles *D. Clintoniana* × *intermedia* rather closely, but its relationship to *D. spinulosa* is shown not only in the glabrous indusia but also in the general habit and cutting of the fronds. From *D. cristata* × *spinulosa*, it differs usually in size and shape of the fronds, but even more decidedly in the amount of cutting.

Dr. Ezra Brainerd's early collection of this hybrid is of especial interest in view of the fact that as a rule the earlier collectors apparently paid little attention to these plants and either overlooked them or were satisfied to refer them to some previously described species. Fern hybrids had been recognized in Europe as early as the '50's, but in America little was done with them until near the close of the century. It is to be noted here that two specimens of what we now know to be a hybrid between *Dryopteris cristata* and *D. marginalis* were identified by the dean of American fern study, Professor Daniel C. Eaton, as his *Aspidium cristatum* var. *Clintonianum*, as can be seen in his herbarium today. The original collection of Judge Clinton is not represented in the Eaton herbarium but according to the late G. E. Davenport in a letter to Miss Margaret Slosson, it is represented in the Museum of Natural Science at Springfield, Massachusetts. As a small photograph of this Springfield material shows it to be somewhat different from

what to-day is ordinarily known as *Dryopteris Clintoniana*, an inquiry as to the exact identity of the type of this species is much to be desired.

Dryopteris cristata × Goldiana hyb. nov.

Fertile fronds tall, up to 120 cm.; stipe pale, clothed with dark scales; lamina narrowly elliptic-lanceolate, acuminate, up to 73 cm. long, 18 cm. broad, once pinnate; pinnae lanceolate above, oblong-lanceolate in the median portion, and deltoid-ovate below, long-acute or slightly acuminate, short-stipitate except in the upper part of the frond, nearly pinnate; pinnulae 12–14 pairs on the median pinnae, oblong, acute or acutish, entire or slightly crenate-serrulate, the costal pinnulae constricted on both sides, the remainder merely notched above or wholly adnate: sori 6–8 on the larger pinnulae, nearer the midvein than the margin; indusia rather thin, glabrous, the cells about as broad as long and in fairly regular radial rows, the walls rather thin, straight or only slightly sinuate.

Type in the Underwood Fern Herbarium, New York Botanical Garden, *W. A. Poyser*, Swarthmore, Pa., June 20, 1908. Also *309 A* and *B* from the same locality and collector, July 15, 1906.

The critical characters on which the identification of this fern is based are, on the one hand, the cell-structure of the indusium, which shows its relationship to *D. Goldiana*, and on the other, its slender outline and broad lower pinnae, which relate it to *D. cristata*. But it shows its relationship to both parents, and is intermediate between them in its stipe-scales, in the shape of the pinnae, in the shape and number of the pinnulae, and in the number and position of sori on each. The type specimen was originally identified by Mr. Poyser as "*Dryopteris Clintoniana* (Eat.) approaching v. *silvatica*," but it differs from this fern in about the same degree that *D. cristata* differs from *D. spinulosa*. The sporangia are all abortive.

Dryopteris Goldiana × spinulosa hyb. nov.

Nephrodium cristatum Clintonianum f. *silvaticum* Poyser, Fern Bull. **16**: 13. [Mr] 1908.

Fronds up to 110 cm. long; stipes pale yellowish, clothed at the base with dark lanceolate scales; lamina elliptic or elliptic-lanceolate, 75 cm. long, 27 cm. broad, very nearly twice pinnate; pinnae mostly oblique to the rachis, varying from oblong-lanceolate in the upper portion of the frond to elliptic-lanceolate or

elliptic in the median portion, and to unequally ovate-lanceolate below, acuminate, stipitate nearly to the apex of the frond; pinnulae about 12–16 pairs on the larger pinnae, narrowly oblong or lanceolate, long-acute, up to 4.5 cm. long, and 1.5 cm. broad, varying from constricted on both sides and serrate-lobed on one third to one half of the larger pinnae to wholly adnate and merely serrulate above, the lobes spinulose-serrulate: sori about 8–10 pairs, about midway between the midveins and margins; indusia glabrous, thin, the cells about as broad as long and in fairly regular radial rows, the walls rather thin, straight or only slightly sinuate.

A year ago when I first saw a specimen of this fern I was inclined to identify it as *D. Clintoniana* × *spinulosa*, assuming that Mr. Poyser had properly related it to the Clinton fern. Afterwards, however, I collected what is certainly *D. Clintoniana* × *spinulosa*, and had to give up this identification for Mr. Poyser's plant. My first valid clue to its identity came when I took occasion to examine the indusia under the microscope and found in them a strong resemblance to the *D. Goldiana* indusia, and corresponding differences from the indusia of the Clinton fern; even then I did not immediately correctly determine the other parent but, having at that time only a narrow frond of f. *silvatica*, referred it to *D. cristata* × *Goldiana*. Recently, however, Mr. Poyser has loaned me all his material, comprising several fronds, all of which have unmistakable *spinulosa* characters in the amount of cutting, in the unequally ovate-lanceolate lower pinnae, and in the oblique habit of nearly all the pinnae, and in the position of the sori. The relationship to Goldie's fern appears in the size and habit of the whole plant, the pinnae widest above the base, as is shown in the original illustration, the numerous pinnulae, together with the shape of the latter and the number of sori on each, and particularly in the structure of the indusia. The last-mentioned characters, with the exception of size, also serve to distinguish *D. Goldiana* × *spinulosa* from *D. Clintoniana*. The material was collected rather too early to allow the question of fertility to be certainly ascertained, but the indications are that the sporangia had aborted.

Dryopteris intermedia × **marginalis** hyb. nov.

Rootstock erect or ascending: fronds in a symmetrical crown, spreading, the stipes thickly clothed at base with lanceolate

scales; laminae lanceolate, elliptical or oblong, acuminate, bipinnate or nearly tripinnate; pinnae lanceolate or oblong-lanceolate to narrowly deltoid, acuminate, rather flexuose, pinnate below; pinnulae oblong or lanceolate, usually blunt and rounded, entire to deeply pinnatifid or sometimes nearly pinnate on the lowest pinnae, the margins entire or dentate, the teeth blunt, entire or tipped with a few very short patent spinules: sori nearer the margins than midveins, the indusia coriaceous, convex, glandular.

Type in the Underwood Fern Herbarium, New York Botanical Garden; *Benedict*, near Solvay, N. Y., Aug. 9, 1905. Also collected by Underwood near Cambridge, Mass., Oct. 11, 1890; *Dowell 3622*, New Springville, Staten Island, N. Y., Nov. 27, 1904; and *Winslow*, Barton Landing, Vt., July 23, 1908.

D. intermedia × *marginalis*, as represented in the material examined, constitutes a very uniformly distinctive plant, which differs from the nearly related × *D. pittsfordensis* * in its obtuse pinnulae and segments, in its spreading flexuose pinnae, and in its glandular indusia. The material collected by Professor Underwood is more divided than the rest and in this respect perhaps shows a greater predominance of *D. intermedia* characters. In Dr. Dowell's collection cited above, some of the pinnulae are more or less acute, but the variation is slight. The hybrid is one of the most easily recognized in the whole series.

In conclusion, I wish to express my thanks to Dr. Ezra Brainerd, Dr. Philip Dowell, Mr. W. A. Poyser, and Mr. E. J. Winslow, for the loan of material.

COLUMBIA UNIVERSITY.

* *Dryopteris pittsfordensis* Slosson, Rhodora 6: 75. 1904 = *Dryopteris marginalis* × *spinulosa* Slosson, nom. nov. The formal publication of this name is made here for the sake of convenience, as no authority has ever been assigned to the name, although Miss Slosson clearly should be considered responsible for it.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1908)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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